REMARKS

Status of Claims

Claims 1 – 28 were original in the application. Claims 1 – 6, 9 – 20, 22 – 26, and 28 have been currently amended. Claims 1 – 28 are submitted for examination on the merits.

Objections to Claims

The Examiner requested that the use of the term, "proof mass" be addressed as applied to all three masses 16, 18 and 20. In paragraph [005] of the substitute specification it is stated:

> The overall dynamical system is comprised of **three proof masses.** The sense-direction oscillator is made up of the second and third masses, designed to amplify response in the sense-mode. The first mass and the combination of the second and third masses form the drive-direction oscillator. The drive and sense-mode oscillators are mechanically decoupled, minimizing instability due to dynamical coupling between the drive and sense modes. (emphasis added)

While it is admitted that proof mass is generally defined to mean "a predetermined test mass in a measuring device or machine, such as in acceleration measurement equipment, which serves as the reference mass for the quantity to be measured," the use in the specification clearly labels the sense and drive masses as all being proof masses. The second and third masses 18 and 20 form part of the sense oscillator. However, all three masses 16, 18, and 20 also form part of the drive oscillator. Therefore in the novel design of the invention, which masses are used to generate a sensed signal and which are used to generate a drive motion is a mixed concept. Therefore, the inventors have chosen in this specification to simply label all

three masses 16, 18 and 20 as proof masses without distinction.

Next, the Examiner questions the use of the term, "mechanically decoupled". Here the term is being used in a dynamic sense to describe the motion relationship between the drive and sense oscillators as opposed to the mechanical connections between the proof masses. As stated at paragraph [049]:

> In order to minimize instability due to dynamical coupling between the drive and sense modes, the drive and sense-mode oscillators 12 and 14 are **mechanically decoupled**. The driven mass 16 oscillates only in the x drive direction, and possible anisoelasticities due to fabrication imperfections are suppressed by the suspension 22 fixed in the y sense direction, best shown in Fig. 4. The second mass 18 oscillates in both x drive and y sense directions, and generates the rotation-induced Coriolis force that excites the sense-direction oscillator 14. The sense direction response of the third mass 20, which comprises the vibration absorber of the sense-mode oscillator 14, is detected for measuring the input angular rate. *Since the springs 24 shown in Fig. 2 that couple the sense mass 20 to mass 18 deform only for relative y sense direction oscillations, instability due to mechanical coupling of drive and sense directions is minimized, significantly enhancing gyroscopic performance due to reduced drift.* (emphasis added)

The claims 1 and 3 have been amended to indicate that the mechanically decoupling is dynamic.

Claims 1, 2, 5, 10, 13, 15, 16 have been responsively amended.

Claim 4 includes antecedent basis for "a sense direction" and "a drive direction" in lines 3 and 4.

Claim 14 in the third line introduces "the third mass and coupled flexures" in the plural.

The applicants respectfully contend that claim 17 has proper sentence structure and have reformatted the claim to make its structure easier to see.

Rejection Pursuant to 35 USC 112

The Examiner questions the use of nonresonant micromachined gyroscope throughout the claims and specification, since resonance peaks are shown. However, the teaching and claims are very clear that the micromachined gyroscope is operated in the flat regions of the drive and sense oscillators, which is a **nonresonant** mode of operation. The existence of a resonant peak somewhere else, which does not enter into the actual operation of the gyro does make the gyro resonant. It is much more accurate and descriptive to emphasize that the gyro is nonresonant.

The Examiner asserts that claim 8 needs claim 9 to make it definite and clear. Applicants respectfully disagree. Claim 8 states that the drive-mode oscillator has a frequency response with two resonant peaks and a flat region between the peaks; and that the sense-mode oscillator also has a frequency response with two resonant peaks and a flat region between the peaks. The gyroscope is operated at a frequency in the flat region of the frequency responses of the drive oscillator and in the flat region of the frequency responses of the drive sense-mode oscillator. Claim 8 is clear and definite. Claim 9 limits claim 8 by requiring the drive-mode oscillator and the sense-mode oscillator to have matching anti-resonance frequencies. This is not a limitation in claim 8 nor would it render claim 8 clearer and more definite by virtue of its inclusion.

The Examiner questions how the intermediate mass is intermediate. The label is largely arbitrary, but has a motivation based on operational principles. Since the design is completely novel, there is no universally accepted prior art terminology for this mass. There are three proof masses (m_1, m_2 and m_3) 16, 18, 20 which are dynamically used to comprise four gyroscopic masses in the operation of the device. Two of the proof

masses are operationally lumped together in the drive oscillator(Fig. 5a), but are operationally separated in the sense oscillator (Fig. 5b). The drive oscillator has an active mass 16 and passive mass 18, 20 (Fig. 5a) and the sense oscillator has an active mass 18 and passive mass 20 (Fig. 5b). Therefore, it must be understood that three physical proof masses are arranged and configured to provide four different operational or gyroscopic masses.

The Coriolis force arises in the passive or intermediate masses 18, 20 of the drive oscillator, the predominant or larger portion 18 which then becomes the active mass in the sense oscillator. Hence, the advantage is that a large Coriolis force is generated by the large mass 18, 20 which is then applied to a much smaller sensing mass 20, which alone would have been much too small to ever generate such a force. A bigger Coriolis force applied to a smaller sensing mass 20 means the gyro will be more sensitive. Paragraph [009] states:

> . . . The Coriolis force that excites the sensing element is generated by the **intermediate proof mass** with a larger mass, resulting in larger Coriolis forces for increased sensor sensitivity so that control system requirements and tight fabrication and packaging tolerances are relaxed, mode-matching is eliminated, and instability and zero-rate drift due to mechanical coupling between the drive and sense modes is minimized.

It is also stated in paragraph [106] that the Coriolis force which generates the sensed signal is arises or is applied to the intermediate masses 18 and 20, which force is then used to drive sense mass 20.

As stated in paragraph [010] the first mass 16 acts as a driven mass and the second mass 18 and third mass 20 act collectively as a passive or intermediate mass 18, 20 to comprise the drive-mode oscillator. The second mass 18 and third mass 20

comprise the active and passive portions of the sense-mode oscillator. Mass 18 is part of a passive or intermediate mass 18, 20 which is **intermediate** between the first (drive) mass 16 and third (sense) mass (20), which mass 18 comprises part of both the drive and sense oscillators respectively. Mass 18 is an **intermediate** link between the drive and sense oscillators. It serves as part of the passive mass in the drive oscillator and is the active mass in the sense oscillator.

The Examiner questions what movement is amplified in claims 2 and 16. Claim 2 states in pertinent part:

> . . . wherein the drive-mode oscillator and sense-mode oscillator by means of their chosen design parameters . . . dynamically amplify movement in a drive direction and in a sense direction . . .

Movement in a drive and sense direction is amplified.

The Examiner questions to what elements the drive and sense directions refer.

Paragraph [010] states:

> The drive-mode oscillator and sense-mode oscillator include a drive means for driving a mass in a drive direction and a sense means for sensing motion of a mass in a sense direction. The three interconnected masses comprise a first 16, second 18 and third mass 20. The first mass 16 is the only mass excited by the drive means. The first mass 16 oscillates in the drive direction and is constrained from movement in the sense direction. The second 18 and third 20 masses are constrained from movement with respect to each other in the drive direction and oscillate together in the drive direction but oscillate independently from each other in the sense direction. The third 20 mass is fixed with respect to the second mass in the drive direction, but is free to oscillate in the sense direction. The first 16 mass acts as a driven mass and the second 18 and third 20 masses act collectively as a passive mass to comprise the drive-mode oscillator. The second 18 and third 20 masses comprise the sense-mode oscillator. (numerals added)

Mass 16 moves only in the x drive direction. Masses 18 and 20 move in both the x drive direction and in the y sense direction. Masses 18 and 20 together in the x drive

direction, but move independent from each other in the y sense direction. This detail of movement as applied to the masses is not a limitation in claim 2, which refers only to the drive and sense oscillators and not the individual masses per se and a property of the drive and sense oscillators to amplify movement. As stated in paragraph [010] the drive oscillator includes first 16, second 18 and third 20 masses. Movement of the first mass 16 in the drive direction can be thought of as the drive motion of the drive oscillator. The sense oscillator includes the second 18 and third 20. Movement of the third mass 20 in the sense direction can be thought of as the sense motion of the sense oscillator. However, what is labeled as the drive or sense motion is a matter of choice, since all motion in the x direction is drive motion and all motion in the y direction is sense motion. The drive and sense oscillators comprises multiple elements or masses. The drive and sense oscillators thus each have elements which move in both the drive and sense directions while the drive oscillator also has an element which moves only in the drive direction. Any insistence that claim 2 characterize a different profile of motion to the drive and sense oscillators misconceives the nature of the invention and seeks to impose on it a definition which is incorrect and not that of the applicant's design.

The Examiner then questions what elements achieve large oscillation amplitudes without resonance. Claim 2 states:

> . . . the drive-mode oscillator and sense-mode oscillator . . . achieve large oscillation amplitudes without resonance. . .

Without the need of lying on top of a resonance peak, i.e. being driven at a resonance peak or sensed at a resonance peak, the elements of the drive oscillator and sense oscillator collectively achieve large oscillation amplitudes.

Claim 16 is similar in each respect mentioned above to claim 2.

Claim 3 is responsively amended.

The Examiner then questions claims 4 and 18 about how the three interconnected masses are related to the first and second masses. Claim 4 states:

> . . . the three interconnected masses comprise a first, second and third mass, . . .

The first of the three interconnected masses is the first mass. The second of the three interconnected masses is the second mass. The third of the three interconnected masses is the third mass. The three masses are different, namely they are the separately denoted a first mass, a second mass and a third mass.

The Examiner then questions claims 5, 17 and 19 with respect to how the second mass generates a Coriolis force. As noted by the Examiner the force applied to the second masses arises from rotation of the gyro by means of the earth's Coriolis force. The second mass in turn generates it own force or rather transmits the earth's Coriolis force to the sense mode oscillator. The Examiner confuses the earth's Coriolis force applied to the second mass with the force transmitted by the second mass to the sense mode oscillator, albeit Coriolis induced. The term "Coriolis" has been dropped to simplify labeling.

Claims 6, 9, 10, 12, 14, 20, 23, 24, 26 and 28 have been responsively amended.

The Examiner also questions claims 10, 12, 24 and 26 with respect to what vibrations are absorbed by the vibration absorber. Claim 10 states:

> . . . the second and the third masses combining to comprise a vibration absorber of the drive-mode oscillator, which vibration absorber mechanically absorbs and amplifies the oscillations of the first mass . . .

Claim 24 is similar.

Claim 12 states:

> . . . where the third mass absorbs vibrations of the sense-mode oscillator to achieve large sense direction oscillation amplitudes due to mechanical amplification . . .

Claim 26 is similar.

The Examiner then questions claims 11 and 25 how the passive mass-spring system moves and what is meant by canceling out the input force. Paragraphs [098] – [100] answer this question. The Examiner appears to be confused by the term "passive" for a moving system. "Passive" doesn't mean that object doesn't move, but that it is the driven part of a system. The first mass 16 is driven by a comb drives supplied with external energy. It is the driving mass in the drive oscillator, therefore it is called the active mass whereas the passive mass-spring system of the second and third masses 18, 20 respond to the force applied to them in a passive manner from the first or active mass 16. In the drive oscillator the second and third masses 18, 20 are called the passive mass-spring system. In the sense oscillator illustrated by Fig. 6b the active or driving mass of the sense system is the second mass 18, which is now viewed as the active mass and the third mass 20 is viewed as the passive-spring system.

When a constant-amplitude sinusoidal force $F_c = F_0 \sin(\omega t)$ is applied to the active mass 16 by the interdigitated comb-drives 28, the steady-state response of the system 12 as illustrated by graph Fig. 6(a) will be as seen as defined by the equation at paragraph [099].

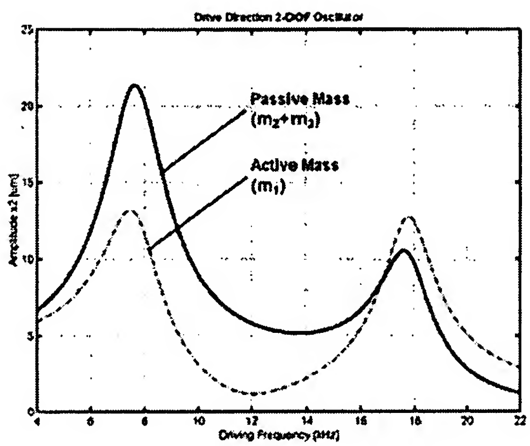

Fig. 6a

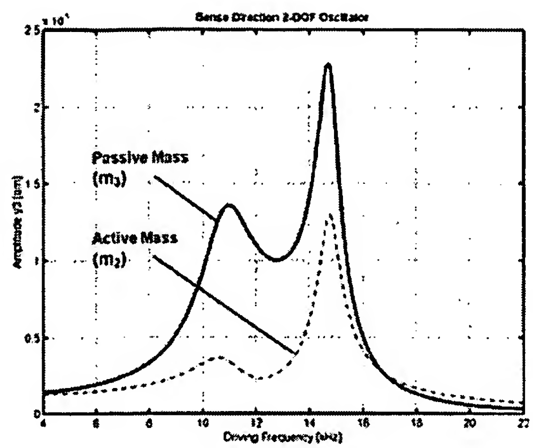

Fig. 6b

When the driving frequency ω_{drive} is matched with the resonant frequency of the isolated passive mass-spring system 40 shown by the alignment of the minimums in the solid and dotted lines in Fig. 6a, i.e., $\omega_{drive} = (k_{2x}/[m_2 + m_3])^{1/2}$, the passive mass 18 and 20 moves to exactly cancel out the input force F_d applied on the active mass, and maximum dynamic amplification is achieved. When in resonance the motion of active mass 16 is being transferred to masses 18, 20 to a maximal extent. The degree of motion may not be equal, but masses 18, 20 move with mass 16. The maximum movement is such that if an input force F_d is applied mass 16, all of that is transferred to masses 18, 20. The force F_d is thus transmitted through mass 16 to masses 18, 20. The net force on mass 16 is thus zero or the input force F_d applied on the active mass 16 is cancelled out. This is the same thing as saying the active mass 16 and passive mass-spring system are in resonance.

In the same way claims 13 and 27 are directed to the situation in Fig. 6b where the third mass 20 comprises an isolated passive mass-spring system and wherein a

sinusoidal Coriolis force in the y sense direction is applied to the second mass 18, and where the frequency of the sinusoidal Coriolis force of mass 18 is matched with a anti-resonant frequency of the isolated passive mass-spring system of the third mass 20 and its coupled flexures, (alignment of the dotted and solid lines in the frequency response of the sense curves of Fig. 6b) so that the third mass 20 achieves maximum dynamic amplification.

The Examiner then questions claim 17 with respect to what the intermediate mass is larger. Claim 17 states:

> . . . where the intermediate proof mass has a **substantially larger mass than the sense element** . . . (emphasis added)

For example, mass 18 is substantially larger or more massive than the sense mass 20.

Applicant respectfully requests advancement of the claims to allowance.

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~~March 9, 2006~~ 14

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